Fermilab

Directorate

MEMORANDUM OF UNDERSTANDING
FOR THE 2013 FERMILAB TEST BEAM FACILITY PROGRAM

T-1036~~XX~~

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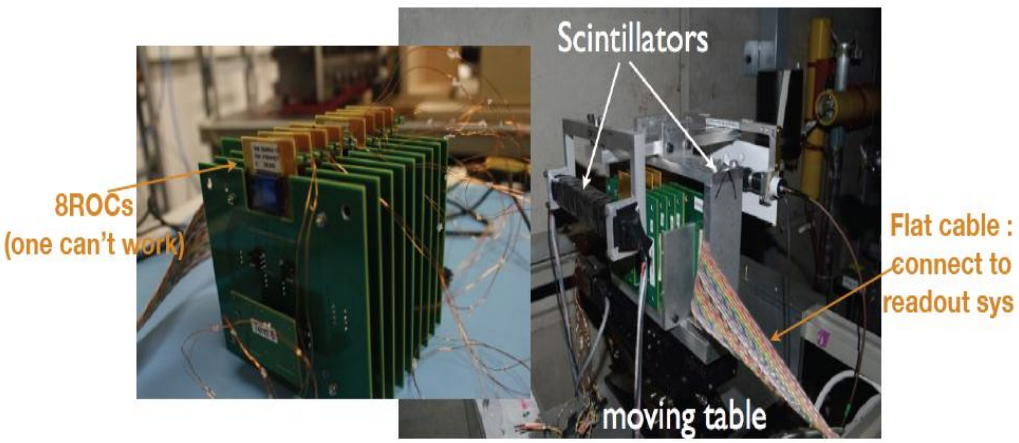
Tests of high rate pixel detector for CMS Upgrade

January 0~~7~~2, 2013



MOU for T-10XX Tests of high rate pixel detector for CMS Upgrade

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INTRODUCTION

This is a memorandum of understanding (MOU) between the Fermi National Accelerator Laboratory (Fermilab) and the experimenters of the CMS Pixel group, which consists of individuals from the CERN, Rutherford Laboratory (UK), National Taiwan University, Bristol University, and Fermilab who have committed to participate in beam tests to be carried out during the 2013 Fermilab Test Beam Facility program.

The memorandum is intended solely for the purpose of recording expectations for budget estimates and work allocations for Fermilab, the funding agencies and the participating institutions. It reflects an arrangement that currently is satisfactory to the parties; however, it is recognized and anticipated that changing circumstances of the evolving research program will necessitate revisions. The parties agree to modify this memorandum to reflect such required adjustments. Actual contractual obligations will be set forth in separate documents.

This MOU fulfills Article 1 (facilities and scope of work) of the User Agreements signed (or still to be signed) by an authorized representative of each institution collaborating on this experiment.

Description of Detector and Tests:

Motivation:

Many modern particle detectors require very high rate tracking capability. One example of this is the CMS tracker, and particularly its silicon pixel detector. The existing detector performs well, but will not continue to perform well as the LHC luminosity is increased. For this reason, the pixel detector will be replaced at least twice. Each new detector will be designed to operate in a greater particle fluence than the one it replaces. Both radiation tolerance and the ability to operate efficiently at high instantaneous rate are required. It is important to verify the rate capability of the new detectors and readout electronics before they are installed in CMS. The first replacement will happen around end of 2016. A new pixel readout chip is currently under development at the Paul Scherer Institute (Switzerland) to handle the forseen high luminosity running of the LHC towards the end of the decade. High rate test beam areas are possible both at CERN and at PSI, but the beam at CERN will not be available during the upcoming LHC long shutdown and it is not possible to make precise measurements of pixel detector readout performance in the low energy pion beam at PSI. We propose to test the high rate tracking capability of the new pixel detectors using the new pixel readout chip in the summer of 2013 at the M03 high rate ~~beam line~~tracking area at Fermilab. Fermilab agrees to modify the M03 area to achieve the required operating conditions for these tests and to accommodate the devices to be tested. The CMS experimenters will provide all the detectors and associated readout electronics and data acquisition system to perform the tests.

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I. PERSONNEL AND INSTITUTIONS:

Spokesperson: Anna Peisert (CERN)

Fermilab liaison: Simon Kwan (SCD), Aria Soha (PPD)

The group members at present are:

	Institution	Country	Collaborator	Rank/Position
1.1	Bristol		S. Nash	
			David Newbold	
			D. Cussans	
1.2	CERN	Switzerland/France	Stefano Mersi	
			Anna Peisert	
1.3	CERN & Karlsruhe	Germany	Andreas Kornmayer	
1.4	Fermilab	USA	Lorenzo Uplegger	
			Simon Kwan	
1.5	National Taiwan U.	Taiwan	Ulysses Grundler	
			Y-M Tzeng	
			Rong Shyang Lu	
1.6	Rutherford & Appleton Laboratory	UK	M. Siyad	
			Kristin Harder	
			G. Zheng	

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Comment [Aria3]: Please use Full Names

II. EXPERIMENTAL AREA, BEAMS AND SCHEDULE CONSIDERATIONS:

2.1 LOCATION

2.1.1 The beam test~~(s)~~ will take place in the MT3 Alcove~~M03~~.

2.1.2 A control room area will be set up for the experimenters in the MS3 service building.~~outside the radiation area is required.~~

2.2 BEAM

2.2.1 BEAM TYPES AND INTENSITIES

Energy of beam: ~~Greater than 50 GeV,~~ 120 GeV ~~preferred.~~
Particles: ~~charged particles.~~protons
Intensity: Adjustable up to 1GHz/cm^2.
Beam spot size: Larger than 1cm x 1cm.
Spill Structure: Gaps between beam must be minimized; At least three consecutive Booster batches of at least 80 bunches are required (with no more than 4 empty RF buckets between batches). The length of the spill and repetition rate are not critical parameters.

2.2.2 BEAM SHARING

Users compatible with the above beam conditions could make use of the MT6 areas, as secondary users.

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2.3 EXPERIMENTAL CONDITIONS

2.3.1 AREA INFRASTRUCTURE

A gap of at least 1 ft. (~5 ft. would be optimal) in the beam vacuum is required. The experimenters will provide instrumentation to measure the beam rate and structure as well as the device(s) under test.

Comment [Aria4]: The gap is 61 inches. Do you need to be able to move the apparatus remotely? And if so, give specs.

2.3.2 ELECTRONICS NEEDS

Please list AC power needs, cabling (to MS3) needs, and networking needs. Also include if there are any computers which will need to be accessed from off-site and if so where they will be located.

How much rack space is needed? In the service building or in the enclosure?

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Particularly describe any non-commercial electronics in depth. Please note electrical diagrams of any non-commercial electronics will need to be submitted two weeks prior to the ORC review.

See Appendix II for summary of PREP equipment pool needs.

2.3.3 DESCRIPTION OF TESTS

How often do you need to access the MT3 alcove? Do you plan to run around the clock?

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Comment [Aria6]: How often would you need to access?

2.4 SCHEDULE

The next iteration of the CMS pixel readout chip developed for the CMS phase 1 pixel detector upgrade will be available in Spring of 2013. Since there will not be test beam available at CERN until end of 2014, ~~we~~ the experimenters would like to carry out the high rate beam test at Fermilab~~-~~ in August of 2013. ~~We~~ The experimenters request a total of two weeks, with the first couple of days for setting up and safety inspection.

III. RESPONSIBILITIES BY INSTITUTION – CMS

The personnel from the participating institutes will provide and set up equipment ~~on~~ in the beamline under the guidance and supervision of the Fermilab Particle Physics Division, provide the pixel detector planes, trigger counters, the DAQ, and all the power supplies. They will provide run plan and coordination. Funding for people participating in the beam test will be provided by the participating institutes.

3.1 CMS PIXEL GROUP

3.1.1 CERN will provide all the scintillation counters and associate electronics and power supplies to form a trigger to readout the pixel system. CERN will also provide all the electronics and software for reading out the pixel system and the DAQ system.

3.1.2 PSI will provide the pixel telescope (up to 4 planes)

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IV. RESPONSIBILITIES BY INSTITUTION – FERMILAB

4.1 FERMILAB ACCELERATOR DIVISION:

4.1.1 Use of MTest beamline as outlined in Section II.
4.1.2 Maintenance of all existing standard beam line elements (SWICs, loss monitors, etc) instrumentation, controls, clock distribution, and power supplies.
4.1.3 Scalers and beam counter signals should be made available in the MS3 control room.
4.1.4 Reasonable access to the equipment in the M03 enclosure.
4.1.5 Connection to beams console and remote logging (ACNET) should be made available.
4.1.6 The test beam energy and beam line elements will be under the control of the AD Operations Department Main Control Room (MCR). [0.5 person-weeks]
4.1.7 Position and focus of the beam on the experimental devices under test will be under control of MCR.
4.1.8 The integrated effect of running this and other SY120 beams will not reduce the neutrino flux by more than an amount set by the office of Program Planning, with the details of scheduling to be worked out between the experimenters and the Office of Program Planning.
~~4.1.1 Modify the M03 area to meet the high rate required by the experiment.~~
~~4.1.2 Provide an area suitable for people and electronics associated with beam counting instrumentation and devices under test.~~
~~4.1.3 Establish suitable running conditions.~~

4.2 FERMILAB PARTICLE PHYSICS DIVISION:

4.2.1 The test-beam efforts in this MOU will make use of the FTBF High Rate Tracking Area. Requirements for the beam and user facilities are given in Section II. The Fermilab Particle Physics Division will be responsible for coordinating overall activities in the MTest beam-line, including use of the user beam-line controls, readout of the beam-line detectors, and FTBF computers. [1.0 person weeks]
~~4.2.1~~4.2.2 Conduct a NEPA review of the experiment.
~~4.2.2~~4.2.3 Provide day-to-day ES~~&~~H&Q support/oversight/review of work and documents as necessary.
~~4.2.3~~4.2.4 Provide safety training as necessary, with assistance from the ES~~&~~H&Q Section.
~~4.2.4~~4.2.5 Update/create ITNA's for users on the experiment.
~~4.2.5~~4.2.6 Initiate the ES~~&~~H&Q Operational Readiness Clearance Review and any other required safety reviews.
~~4.2.6~~4.2.7 Provide support for ~~setting up~~ the moving table, as specified in section 2.3.1.

Comment [Aria7]: Details need to be specified in section 2.3.1

4.3 FERMILAB SCIENTIFIC COMPUTING ~~SECTOR~~DIVISION

4.3.1 Internet access should be continuously available in the MS3 control room~~Provide Internet access for equipment in the counting house~~.
4.3.2 See Appendix II for summary of PREP equipment pool needs.

4.4 FERMILAB ES&H&Q SECTION

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4.4.1 Assistance with safety reviews.

4.4.2 Provide safety training, with assistance from PPD, as necessary for experimenters. [0.4 person-weeks]

V. SUMMARY OF COSTS

Source of Funds [$K]	Materials & Services	Labor (person-weeks)
Particle Physics Division	0	2
Accelerator Division	0	1
Scientific Computing ~~Sector~~Division	0	0
ES~~&~~H&Q Section	0	0.4
Totals Fermilab	0	3.4
Totals Non-Fermilab	$40000 (existing eqp)	30**

** 6 people for two weeks for data-taking, 6 person-weeks in preparing the hardware; 12 person-weeks of data analysis.

VI. GENERAL CONSIDERATIONS

6.1 The responsibilities of the Spokesperson and the procedures to be followed by experimenters are found in the Fermilab publication "Procedures for Researchers": (http://www.fnal.gov/directorate/PFX/PFX.pdf). The Spokesperson agrees to those responsibilities and to ensure that the experimenters all follow the described procedures.

6.2 To carry out the experiment a number of Environmental, Safety and Health (ES~~&~~H&Q) reviews are necessary. This includes creating an Operational Readiness Clearance document in conjunction with the standing Particle Physics Division committee. The Spokesperson will follow those procedures in a timely manner, as well as any other requirements put forth by the Division's Safety Officer.

6.3 The Spokesperson will ensure at least one person is present at ~~the Fermilab Test Beam Facility~~MS3 whenever beam is delivered and that this person is knowledgeable about the experiment's hazards.

6.4 All regulations concerning radioactive sources will be followed. No radioactive sources will be carried onto the site or moved without the approval of the Fermilab ES~~&~~H&Q section.

6.5 All items in the Fermilab Policy on Computing will be followed by the experimenters. (http://computing.fnal.gov/cd/policy/cpolicy.pdf).

6.6 The Spokesperson will undertake to ensure that no PREP or computing equipment be transferred from the experiment to another use except with the approval of and through the mechanism provided by the Computing Sector management. The Spokesperson also undertakes to ensure no modifications of PREP equipment take place without the knowledge and written consent of the Computing Sector management.

6.7 The experimenters will be responsible for maintaining both the electronics and the computing hardware supplied by them for the experiment. Fermilab will be responsible for repair and maintenance of the Fermilab-supplied electronics listed in Appendix II. Any items for which the experiment requests that Fermilab performs maintenance and repair should appear explicitly in this agreement.

At the completion of the experiment:

6.8 The Spokesperson is responsible for the return of all PREP equipment, computing equipment and non-PREP data acquisition electronics. If the return is not completed after a period of one year after the end of running the Spokesperson will be required to furnish, in writing, an explanation for any non-return.

6.9 The experimenters agree to remove their experimental equipment as the Laboratory requests them to. They agree to remove it expeditiously and in compliance with all ES~~&~~H&Q requirements, including those related to transportation. All the expenses and personnel for the removal will be borne by the experimenters unless removal requires facilities and personnel not able to be supplied by them, such a rigging, crane operation, etc.

6.10 The experimenters will assist Fermilab with the disposition of any articles left in the offices they occupied.

6.11 An experimenter will be available to report on the test beam effort at a Fermilab All Experimenters' Meeting.

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SIGNATURES:

_____ / / 2013
Anna Peisert, Experiment Spokesperson

_____ / / 2013
Michael Lindgren, Particle Physics Division, Fermilab

_____ / / 2013
Roger Dixon, Accelerator Division, Fermilab

_____ / / 2013
Rob Roser, Scientific Computing -Division, Fermilab

_____ / / 2013
Nancy Grossman, ES~~&~~H&Q Section, Fermilab

_____ / /2013
Greg Bock, Associate Director for Research, Fermilab

_____ / /2013
Stuart Henderson, Associate Director for Accelerators, Fermilab

APPENDIX I: AREA LAYOUT

Detector apparatus will be set up in MT3 alcove, within the M03 enclosure. The apparatus will be monitored from the MS3 service building, in an area set aside for users.

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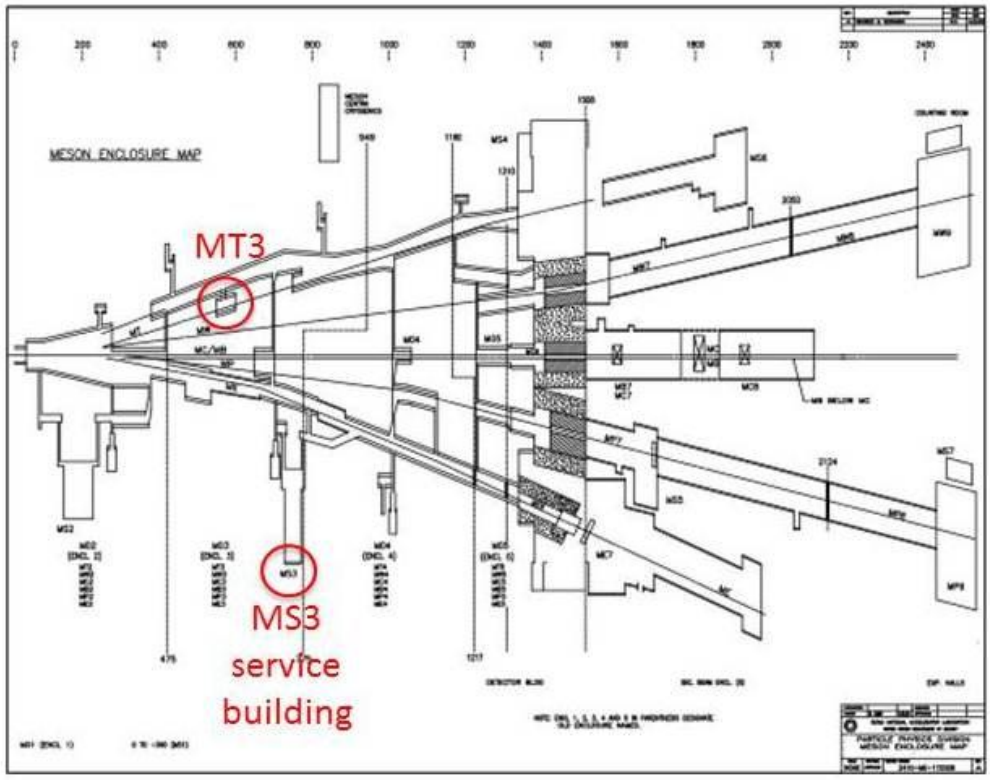

APPENDIX II: EQUIPMENT NEEDS

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Equipment Pool and PPD items needed for Fermilab test beam, on the first day of setup.

PREP EQUIPMENT POOL:

Quantity	Description
1	NIM Bin with cooling fan
1	Discriminator unit (e.g. LeCroy 621 Quad Discriminator)
1	Coincidence unit (.e.g. LeCroy 465 4-fold coincidence module)
1	Gate generator 9e.g. LeCroy 222 Dual Gate and delay module)
1	PMT power supply (e.g. LeCroy 1460 HV system)
2	LeCroy 1461 Negative HV supply card

APPENDIX III: - HAZARD IDENTIFICATION CHECKLIST

Flammable Gases or Liquids		Other Gas Emissions		Hazardous Chemicals		Other Hazardous /Toxic Materials
Type:		Type:			Cyanide plating materials	List hazardous/toxic materials planned for use in a beam line or an experimental enclosure:
Flow rate:		Flow rate:			Hydrofluoric Acid	
Capacity:		Capacity:			Methane	
Radioactive Sources		**Target Materials**			photographic developers	
	Permanent Installation		Beryllium (Be)		PolyChlorinatedBiphenyls	
X	Temporary Use		Lithium (Li)		Scintillation Oil	
Type:	Strontium		Mercury (Hg)		TEA	
Strength:	low		Lead (Pb)		TMAE	
Lasers			Tungsten (W)		Other: Activated Water?	
	Permanent installation		Uranium (U)			
	Temporary installation		Other:	**Nuclear Materials**		
	Calibration	**Electrical Equipment**		Name:		
	Alignment		Cryo/Electrical devices	Weight:		
Type:			Capacitor Banks	**Mechanical Structures**		
Wattage:		**X**	High Voltage (50V)		Lifting Devices	
MFR Class:			Exposed Equipment over 50 V		Motion Controllers	
		X	Non-commercial/Non-PREP		Scaffolding/ Elevated Platforms	
			Modified Commercial/PREP		Other:	
Vacuum Vessels		**Pressure Vessels**		**Cryogenics**		
Inside Diameter:		Inside Diameter:			Beam line magnets	
Operating Pressure:		Operating Pressure:			Analysis magnets	
Window Material:		Window Material:			Target	
Window Thickness:		Window Thickness:			Bubble chamber	

OTHER GAS EMISSION

Greenhouse Gasses (Need to be tracked and reported to DOE)

- ❑ Carbon Dioxide, including CO_2 mixes such as Ar/CO_2
- ❑ Methane
- ❑ Nitrous Oxide
- ❑ Sulfur Hexafluoride
- ❑ Hydro fluorocarbons
- ❑ Per fluorocarbons
- ❑ Nitrogen Trifluoride

NUCLEAR MATERIALS

Reportable Elements and Isotopes / Weight Units / Rounding

Name of Material	MT Code	Reporting Weight Unit Report to Nearest Whole Unit	Element Weight	Isotope Weight	Isotope Weight %
Depleted Uranium	10	Whole Kg	Total U	U-235	U-235
Enriched Uranium	20	Whole Gm	Total U	U-235	U-235
Plutonium-242[1]	40	Whole Gm	Total Pu	Pu-242	Pu-242
Americium-241[2]	44	Whole Gm	Total Am	Am-241	–
Americium-243[2]	45	Whole Gm	Total Am	Am-243	–
Curium	46	Whole Gm	Total Cm	Cm-246	–
Californium	48	Whole Microgram	–	Cf-252	–
Plutonium	50	Whole Gm	Total Pu	Pu-239+Pu-241	Pu-240
Enriched Lithium	60	Whole Kg	Total Li	Li-6	Li-6
Uranium-233	70	Whole Gm	Total U	U-233	U-232 (ppm)
Normal Uranium	81	Whole Kg	Total U	–	–
Neptunium-237	82	Whole Gm	Total Np	–	–
Plutonium-238[3]	83	Gm to tenth	Total Pu	Pu-238	Pu-238
Deuterium[4]	86	Kg to tenth	D_2O	D_2	
Tritium[5]	87	Gm to hundredth	Total H-3	–	–
Thorium	88	Whole Kg	Total Th	–	–
Uranium in Cascades[6]	89	Whole Gm	Total U	U-235	U-235

[1] Report as Pu-242 if the contained Pu-242 is 20 percent or greater of total plutonium by weight; otherwise, report as Pu 239-241.

[2] Americium and Neptunium-237 contained in plutonium as part of the natural in-growth process are not required to be accounted for or reported until separated from the plutonium.

[3] Report as Pu-238 if the contained Pu-238 is 10 percent or greater of total plutonium by weight; otherwise, report as plutonium Pu 239-241.

[4] For deuterium in the form of heavy water, both the element and isotope weight fields should be used; otherwise, report isotope weight only.

[5] Tritium contained in water (H2O or D2O) used as a moderator in a nuclear reactor is not an accountable material.

[6] Uranium in cascades is treated as enriched uranium and should be reported as material type 89.